CLAIMS

What is claimed:

1. A suspension assembly for use in supporting a first actuation element of a microelectromechanical system and allowing movement of said first actuation element relative to a base substrate, wherein said suspension assembly comprises:

a longitudinal center beam comprising elongate first and second lateral sides; and

a plurality of first lateral beams extending out from said center beam, wherein, when said center beam of said suspension assembly is actuated, at least one of said plurality of said first lateral beams are stretched.

2. A suspension assembly, as claimed in Claim 1, wherein said plurality of said first lateral beams is anchored to said base substrate.

3. A suspension assembly, as claimed in Claim 1, further comprising an actuation assembly, wherein said actuation assembly comprises a plurality of actuation beams oriented substantially parallel to said center beam and interconnected with ones of said plurality of said first lateral beams.

4. A suspension assembly, as claimed in Claim 3, wherein said actuation assembly is disposed between said base substrate and said plurality of said first lateral beams.

5. A suspension assembly, as claimed in Claim 3, wherein said first actuation element is interconnected to at least one of said plurality of said actuation beams.

6. A suspension assembly, as claimed in Claim 3, wherein said actuation assembly comprises a plurality of second lateral beams oriented substantially perpendicular to said center beam and extending between and interconnecting said plurality of said actuation beams.

7. A suspension assembly, as claimed in Claim 6, wherein said first actuation element is interconnected to at least one of said plurality of said second lateral beams.

8. A suspension assembly, as claimed in Claim 3, further comprising a support assembly, wherein said support assembly comprises a first central beam and a second central beam adjacent to said first central beam and a plurality of third and fourth lateral beams extending out from said first and second central beams.

9. A suspension assembly, as claimed in Claim 8, wherein said plurality of said third lateral beams are interconnected with said plurality of said first lateral beams, and wherein said plurality of said third lateral beams are also stretched when said center beam is actuated.

10. A suspension assembly, as claimed in Claim 8, wherein said plurality of said fourth lateral beams are interconnected with said plurality of said first lateral beams, and wherein said plurality of said fourth lateral beams are also flexed when said center beam is actuated.

11. A suspension assembly, as claimed in Claim 10, wherein said plurality of said actuation beams of said actuation assembly are disposed between and interconnected with said plurality of said first lateral beams and said plurality of said fourth lateral beams.

12. A suspension assembly for use in supporting a first actuation element of a microelectromechanical system and allowing movement of said first actuation element relative to a base substrate, wherein said suspension assembly comprises:

a longitudinal center beam comprising elongate first and second lateral sides; and

a plurality of first and second lateral beams extending out from said center beam, wherein, when said center beam of said suspension assembly is actuated, said plurality of said first lateral beams are stretched, and said plurality of said second lateral beams are flexed.

13. A suspension assembly, as claimed in Claim 12, wherein said plurality of said first lateral beams are anchored to said base substrate.

14. A suspension assembly, as claimed in Claim 12, wherein said plurality of said second lateral beams are free of restrictive connections to said base substrate.

15. A suspension assembly, as claimed in Claim 12, further comprising an actuation assembly, wherein said actuation assembly comprises a plurality of actuation beams oriented substantially parallel to said center beam and interconnected with ones of said plurality of said second lateral beams.

16. A suspension assembly, as claimed in Claim 15, wherein said actuation assembly is disposed between said base substrate and said plurality of said first and second lateral beams.

17. A suspension assembly, as claimed in Claim 15, wherein said first actuation element is interconnected to at least one of said plurality of said actuation beams.

18. A suspension assembly, as claimed in Claim 15, wherein said actuation assembly comprises a plurality of third lateral beams extending between and interconnected with said plurality of said actuation beams.

19. A suspension assembly, as claimed in Claim 18, wherein said first actuation element is interconnected to at least one of said plurality of said third lateral beams.

20. A suspension assembly, as claimed in Claim 15, further comprising a support assembly, wherein said support assembly comprises a first central beam and a second central beam adjacent to said first central beam and a plurality of fourth and fifth lateral beams extending out from said first and second central beams.

21. A suspension assembly, as claimed in Claim 20, wherein said plurality of said fourth lateral beams are interconnected with said plurality of said first lateral beams, and wherein said plurality of said fourth lateral beams are also stretched when said center beam is actuated.

22. A suspension assembly, as claimed in Claim 20, wherein said plurality of said fifth lateral beams are interconnected with said plurality of said second lateral beams, and wherein said plurality of said fifth lateral beams are also flexed when said center beam is actuated.

23. A suspension assembly, as claimed in Claim 22, wherein said plurality of said actuation beams of said actuation assembly are disposed between and interconnected with said plurality of said second lateral beams and said plurality of said fifth lateral beams.

24. A suspension assembly, as claimed in Claim 20, wherein said plurality of said fifth lateral beams are free of restrictive connections to said base substrate.

25. A suspension assembly for use in supporting a first actuation element of a microelectromechanical system and allowing movement of said first actuation element of a microelectromechanical system relative to a base substrate, wherein said suspension assembly comprises:

a longitudinal center beam comprising elongate first and second lateral sides; and

first, second, third, and fourth lateral beams extending out from said center beam, wherein said first and second lateral beams extend from said first lateral side of said center beam, and wherein said third and fourth lateral beams extend out from said second lateral side of said center beam, wherein said first, second, third, and fourth lateral beams comprise respective first, second, third, and fourth attachment ends attached to said center beam and respective first, second, third, and fourth peripheral ends disposed most remote from corresponding said first, second, third, and fourth attachment ends,

wherein said first, second, third, and fourth peripheral ends of respective said first, second, third, and fourth lateral arms are anchored to the base substrate,

wherein, when said center beam of said suspension assembly is in a resting position, each of said first, second, third, and fourth lateral beams comprises a nominal length,

wherein, when said center beam of said suspension assembly is in a displaced position, each of said first, second, third, and fourth lateral beams comprises a stretched length, and

wherein said stretched length is longer than said resting length of each of said first, second, third, and fourth lateral beams.

26. A suspension assembly, as claimed in Claim 25, wherein said longitudinal center beam comprises first and second beams that are joined together.

27. A suspension assembly, as claimed in Claim 26, wherein said first and second beams are joined together through a homogenous interface.

28. A suspension assembly, as claimed in Claim 25, wherein said first, second, third, and fourth lateral beams are substantially perpendicular to said center beam when said center beam is in a resting position.

29. A suspension assembly, as claimed in Claim 25, further comprising first and second flexure beams, wherein said first flexure beam extends out from said first lateral side of said center beam, wherein said second flexure beam extends out from said second lateral side of said center beam, wherein said first and second flexure beams comprise respective first and second proximal ends connected to said center beam and respective first and second distal ends disposed most remote from corresponding said first and second proximal ends.

30. A suspension assembly, as claimed in Claim 29, wherein said first and second distal ends of respective said first and second flexure beams are free from attachment to said base substrate.

31. A suspension assembly, as claimed in Claim 29, wherein said first and second flexure beams are capable of flexure or pivoting about respective first and second proximal ends of respective said first and second flexure beams.

32. A suspension assembly, as claimed in Claim 29, wherein said first flexure beam is disposed between said first and second lateral beams, and wherein said second flexure beam is disposed between said third and fourth lateral beams.

33. A suspension assembly, as claimed in Claim 29, wherein, when said center beam of said suspension assembly is in a displaced position, said center beam is displaced by a first distance with respect to said base substrate, and said first and second distal ends of respective said first and second flexure beams are each displaced by a second distance greater than said first distance with respect to said base substrate.

34. A suspension assembly, as claimed in Claim 29, further comprising third and fourth flexure beams, wherein said third flexure beam extends out from said first lateral side of said center beam, wherein said fourth flexure beam

extends out from said second lateral side of said center beam, wherein said third and fourth flexure beams comprise respective third and fourth proximal ends connected to said center beam and respective third and fourth distal ends disposed most remote from corresponding said third and fourth proximal ends.

35. A suspension assembly, as claimed in Claim 34, further comprising a first actuation beam interconnected with said first and third distal ends of respective said first and third flexure beams, and a second actuation beam interconnected with said second and fourth distal ends of respective said second and fourth flexure beams.

36. A suspension assembly, as claimed in Claim 35, wherein said first and second actuation beams are disposed between respective said flexure beams and said base substrate.

37. A suspension assembly, as claimed in Claim 35, wherein respective said flexure beams are disposed between said first and second actuation beams and said base substrate.

38. A suspension assembly, as claimed in Claim 35, wherein said first and second actuation beams are substantially parallel to said center beam.

39. A suspension assembly, as claimed in Claim 35, wherein said first actuation beam is substantially perpendicular to said first and third flexure beams, and wherein said second actuation beam is substantially perpendicular to said second and fourth actuation beams.

40. A suspension assembly, as claimed in Claim 35, wherein said first actuation element is interconnected with at least one of said first and second actuation beams.

41. A method of supporting a first structure of a microelectromechanical system, the method comprising the steps of:

providing a second structure with an attractive electrostatic force urging said first structure in a first direction toward said second structure;

applying a spring force comprising at least a first force vector oriented in a second direction opposite of said first direction to bias said first structure away from said second structure; and

applying a tensile force comprising at least a second force vector oriented in third direction opposite of said first direction and substantially aligned with said second direction to bias said first structure away from said second structure.

42. A method, as claimed in Claim 41, wherein said providing step comprises supplying said second structure with a voltage.

43. A method, as claimed in Claim 41, wherein said applying a spring force step comprises flexing of a first support component.

44. A method, as claimed in Claim 43, wherein said applying a tensile force step comprises stretching said first support component.

45. A method, as claimed in Claim 41, wherein said applying a tensile force comprises stretching a first support component.

46. A method, as claimed in Claim 45, wherein said applying a spring force comprises flexing a second support component.

47. A method, as claimed in Claim 41, wherein said first and second structures comprise electrostatic combs.

48. A suspension assembly for a first moveable element of a microelectromechanical system, wherein said suspension assembly comprises:

a base substrate;

support structure interconnected with said first moveable element of said microelectromechanical system; and

first linkage structure interconnected with said support structure, wherein said first linkage structure allows for movement of said actuation structure across a range of positions relative to said substrate in response to a corresponding range of actuation forces applied to said actuation structure, wherein said range of positions includes a first position corresponding to a first actuation force value of zero or greater and a second position corresponding to a second actuation force greater than said first actuation force, and wherein said first linkage structure provides a nonlinear resistance force against said actuation force such that said resistance force varies in a nonlinear fashion with respect to positions within said range of positions.

49. A suspension assembly, as claimed in Claim 48, wherein said first position comprises said first actuator element dissociated from a second actuator element.

50. A suspension assembly, as claimed in Claim 49, wherein said first and second actuator elements comprise electrostatic combs.

51. A suspension assembly, as claimed in Claim 48, wherein said second position comprises said first actuator element disposed in an operatively interfacing relationship with a second actuator element.

52. A suspension assembly, as claimed in Claim 51, wherein said first and second actuator elements comprise electrostatic combs.

53. A suspension assembly, as claimed in Claim 51, wherein said second actuator element comprises a stationary electrostatic comb.

54. A suspension assembly, as claimed in Claim 48, wherein said second actuation force comprises a range of 10 micronewtons to 10 millinewtons.

55. A suspension assembly, as claimed in Claim 48, wherein said nonlinear resistance force comprises a tensile force associated with a stretching of said first linkage structure.

56. A suspension assembly, as claimed in Claim 48, wherein said first linkage structure comprises at least three layers of polysilicone.

57. A suspension assembly, as claimed in Claim 48, wherein said actuation structure only interconnects with said base substrate via said first linkage structure.

58. A suspension assembly, as claimed in Claim 48, wherein said actuation structure avoids direct contact with said base substrate.

59. A suspension assembly, as claimed in Claim 48, wherein said actuation structure is suspended over said base substrate by said first linkage structure.

60. A suspension assembly, as claimed in Claim 48, wherein said actuation structure comprises at least one linkage channel, and wherein at least a portion of said first linkage structure passes through said at least one linkage channel so as to enable said actuation structure to move without interference from said first linkage structure.

61. A suspension assembly, as claimed in Claim 60, wherein said at least one linkage channel is oblong or elliptical.